Fig. 1

Equation Number	Chemical Equation	Remarks
EQ 1	$2\,Al + 3H_2O \rightarrow Al_2O_3 + 3H_2 + 946.2$ (KJ/mol)	Explosive event, hydrogen gas produced
EQ 2	$2Al + 3CuO \rightarrow Al_2O_3 + 3Cu + 1203.0$ (KJ/mol)	Non-explosive event, no gaseous product
EQ 3	$C_3H_6O_6N_6 \rightarrow 0.77CO_2 + 2.23CO + 2.23H_2O + 0.77H_2 + 3N_2 + 1145.76$ (KJ/mol)	RDX decomposition by detonation
EQ 4	$2Al + 3CO_2 \rightarrow Al_2O_3 + 3CO + 820.6$ (KJ/mol)	CO_2 as a detonation product
EQ 5	$2Al + 0.77CO_2 + 2.23H_2O \rightarrow Al_2O_3 + 0.77CO + 2.23H_2 + 914.0$ (KJ/mol)	Complete reaction between RDX detonation products and Al
EQ 6	$xAl + 0.385xCO2 + 1.115xH_2O \rightarrow 0.5xAl_2O_3 + 0.385xCO + 1.115xH_2 + 457.0x$ (KJ/mol)	Complete reaction between RDX detonation products and x moles of Al, $0 <= x <= 2$
EQ 7	$C_3H_6O_6N_6 + xAl \rightarrow (0.77 - 0.385x)CO_2 + (2.23 + 0.385x)CO + (2.23 - 1.115x)H_2O + (0.77 + 1.115x)H_2 + 3N_2 + 0.5xAl_2O_3 + (1145.76 + 457.0x)$ (KJ/mol)	Complete reaction between 1 mole of RDX and x moles of Al, $0 <= x <= 2$
EQ 8	$C_3H_6O_6N_6 + xAl \rightarrow 3CO + 3H_2O + 3N_2 + Al_2O_3 + x\,Al + 2060.0$ (KJ/mol)	RDX/Al mixture to produce Al in molten state, $x => 2$
EQ 9	$2Al + 3NH_4NO_3 \rightarrow Al_2O_3 + 6H_2O + 3N_2 + 2023.43$ (KJ/mol)	AN dissolved in water to increase reactivity and to decrease Al temperature for complete chemical reaction
EQ 10	$3CuO + x\,Al \rightarrow Al_2O_3 + 3CuO + (x-2)Al + 1024.0$ (KJ/mol)	CuO/Al mixture to produce Al in molten state, $x => 2$
EQ 11	$Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe + 846.0$ (KJ/mol)	Thermite reaction, mixture used to produce Al in molten state when Al is surplus in stoichiometry

Fig. 2

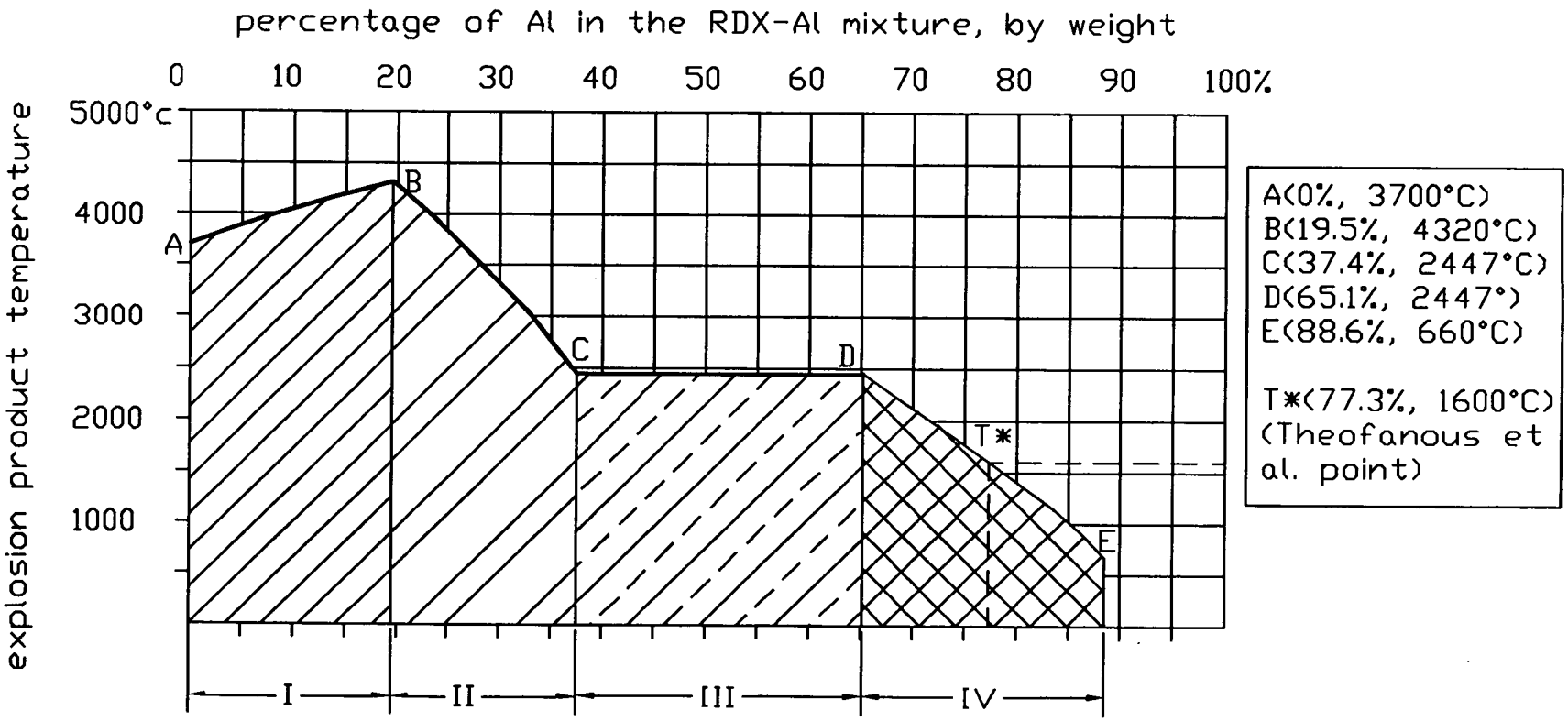

percentage of Al in the RDX-Al mixture, by weight
0
10
20
30
40
50
60
70
80
90
100%
explosion product temperature
5000°c
4000
3000
2000
1000
A
B
C
D
T*
E
I
II
III
IV
A(0%, 3700°C)
B(19.5%, 4320°C)
C(37.4%, 2447°C)
D(65.1%, 2447°)
E(88.6%, 660°C)
T*(77.3%, 1600°C)
(Theofanous et al. point)

Fig.3

Name of Oxygen Carrier	Molecular Formula	Oxygen Balance	Solubility in Water	Decomp. Temp.	Remarks
Sodium Nitrate	$NaNO_3$	47% (Na_2O, N_2)	84.5 g/100 ml (20°C)	380°C	Used as oxidizer in propellant, commercial explosives and black powder
Potassium Nitrate	KNO_3	39.6% (K_2O, N_2)	38.5 g/100 ml (25°C)	400°C	Used in pyrotechnics, commercial explosives, black powder, propellants and matches
Barium Nitrate	$Ba(NO_3)_2$	30.6% (BaO, N_2)	8.7 g/100 ml (20°C)	800°C	Used as oxidizer in propellants and pyrotechnics
Ammonium Nitrate	NH_4NO_3	20% (H_2O, N_2)	192 g/100ml (20°C)	210°C	Well-known fertilizer. Used in propellants and commercial explosives
Lithium Perchlorate, LP	$LiClO_4$	60.2% (LiCl)	59.7 g/100ml (25°C)	400°C	Used as oxidizer in rocket and missile propellant
Potassium Perchlorate	$KClO_4$	46.19% (KCl)	18.2 g/100ml (100°C)	530°C	Used as oxidizer in rocket propellant and in explosives
Strontium Perchlorate	$Sr(ClO_4)_2$	44.64% (SrCl)	309.7 g/100ml (25°C)	477°C	Used as oxidizer in propellants
Ammonium Perchlorate	NH_4ClO_4	34.04%	20 g/100ml (25°C)	200~300°C (low temperature decomposition)	Predominantly used as oxidizer in solid propellants for missiles and rockets
Potassium Chlorate	$KClO_3$	39.17%	56.2 g/100ml (100°C)	400°C	Used with fuel to make explosives, also used in pyrotechnics and match head
Sodium Chlorate	$NaClO_3$	45.10%	100 g/100ml (20°C)	melting point 248°C	Moisture absorbing, not very often used in explosives

Fig. 4

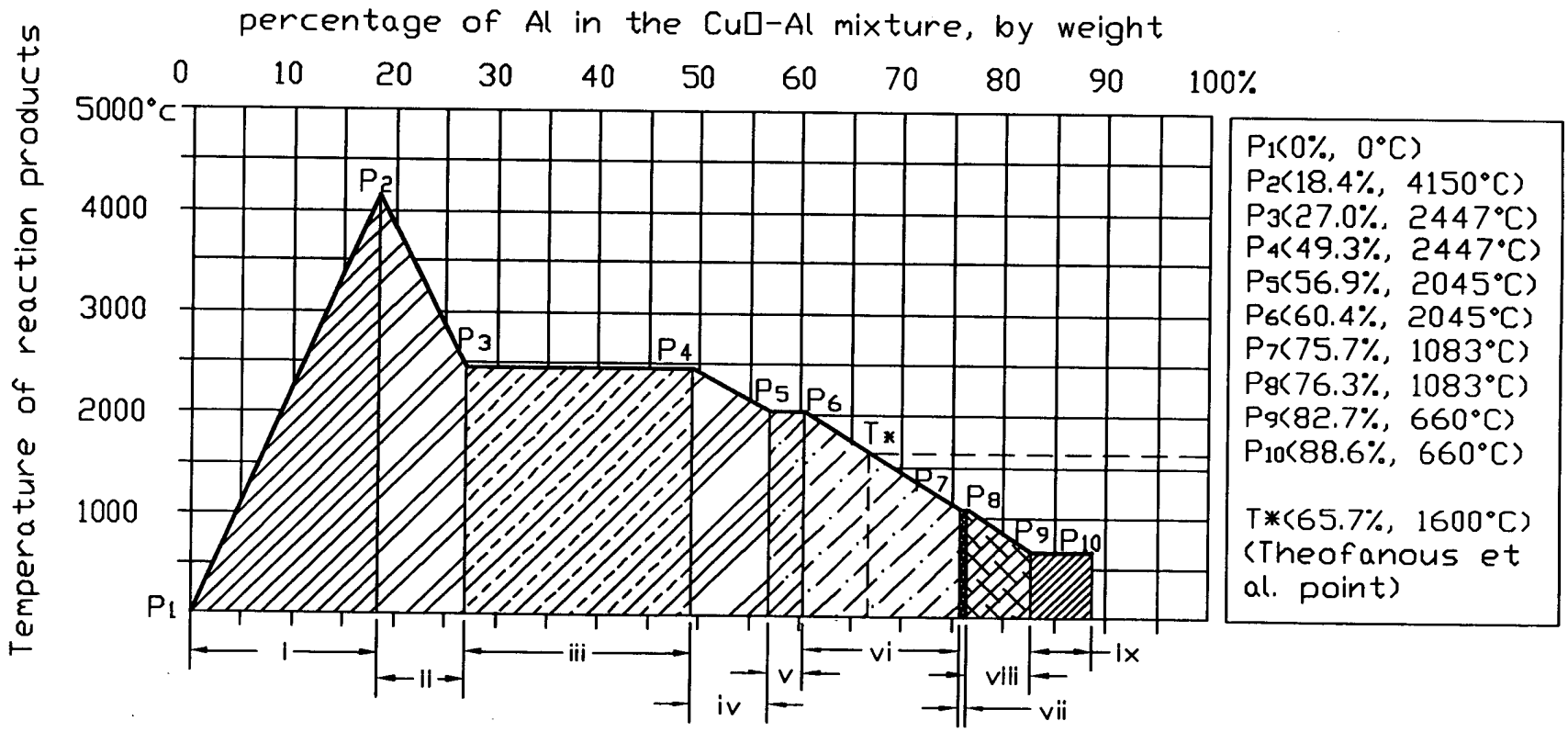


Fig. 5

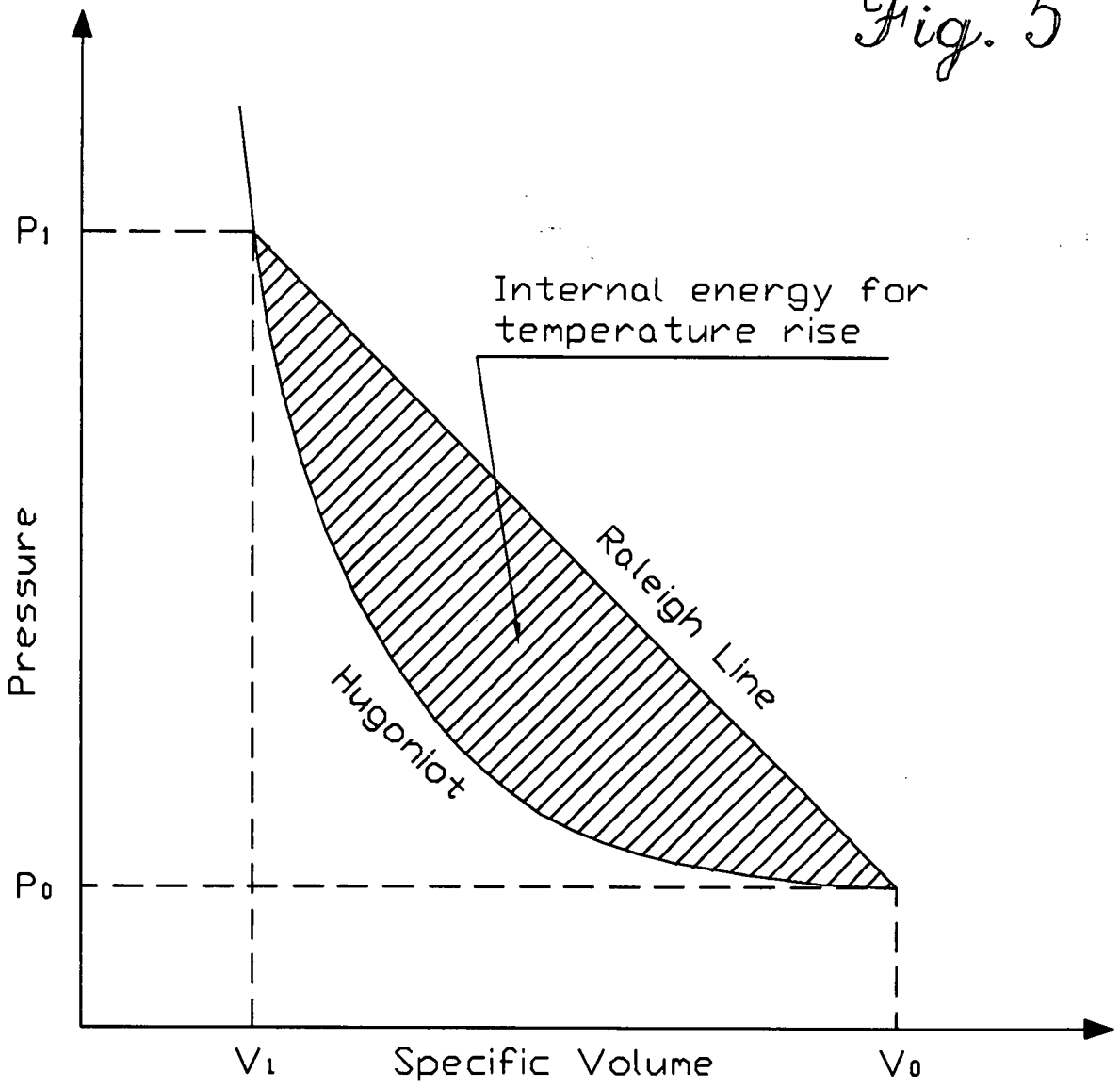

P1
P0
Pressure
Internal energy for
temperature rise
Raleigh Line
Hugoniot
V1
Specific Volume
V0

Fig. 6

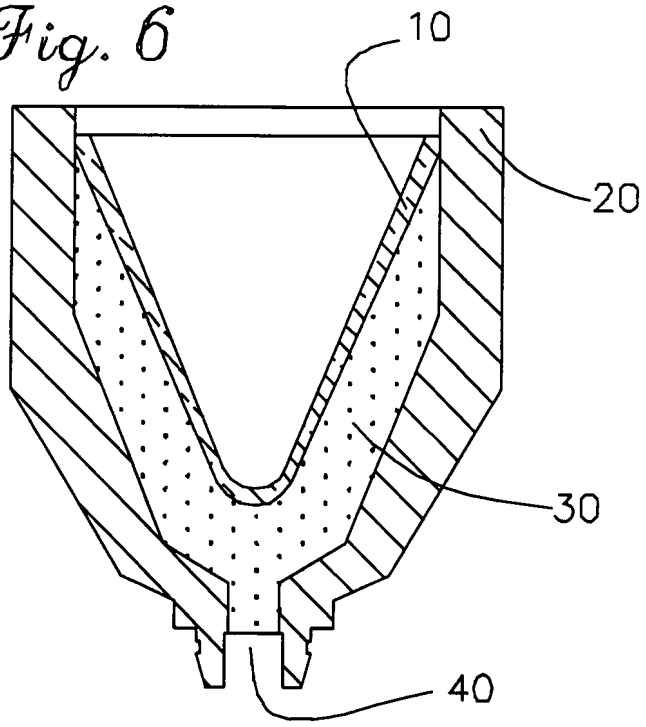


Fig. 7

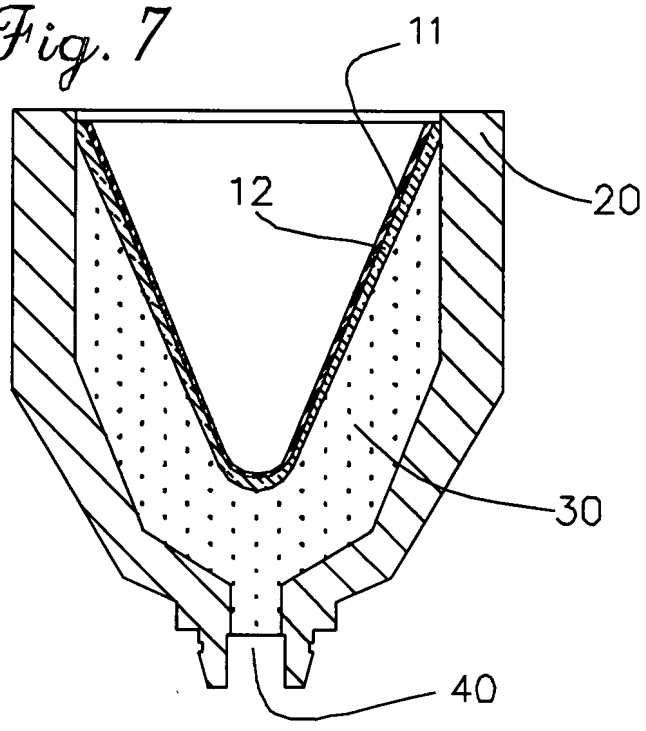
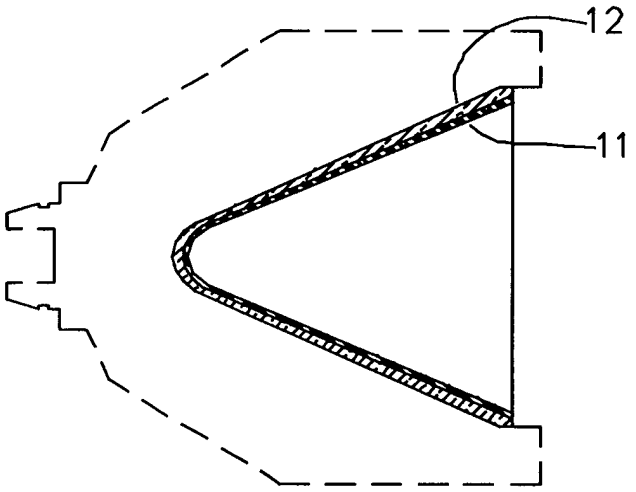


Fig. 8

(a)



(b)

Fig. 9

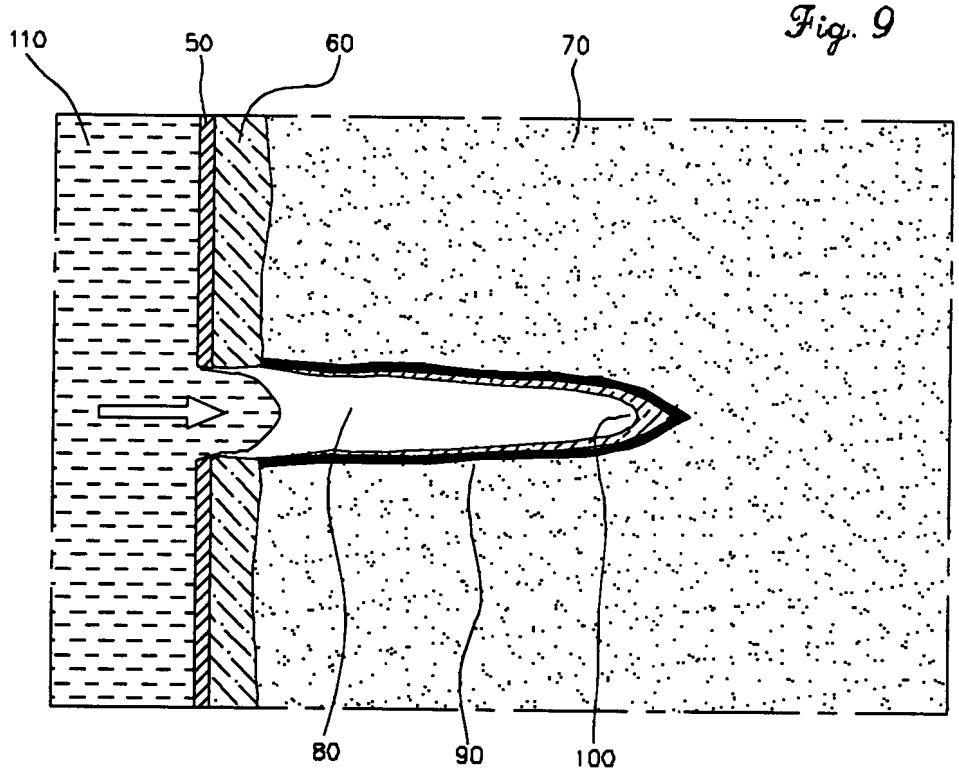


Fig. 10

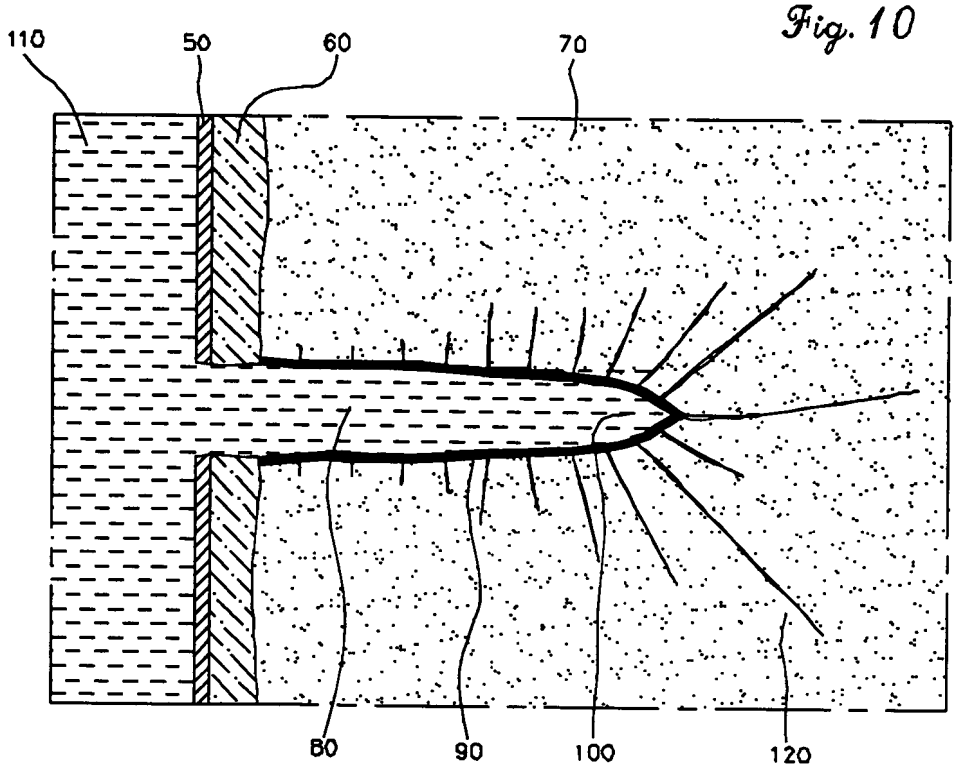


Fig. 11

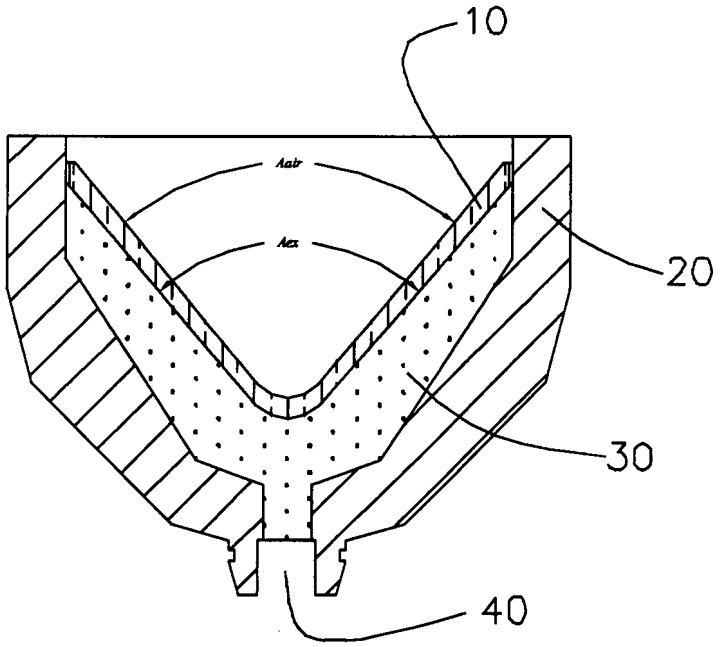


Fig. 12

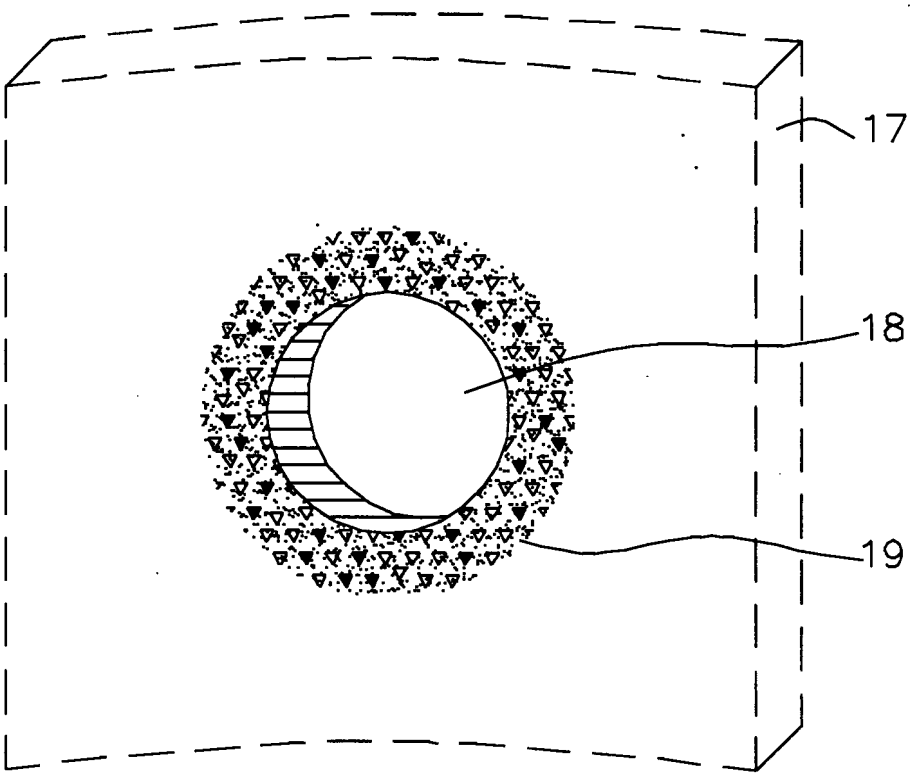


Fig. 13

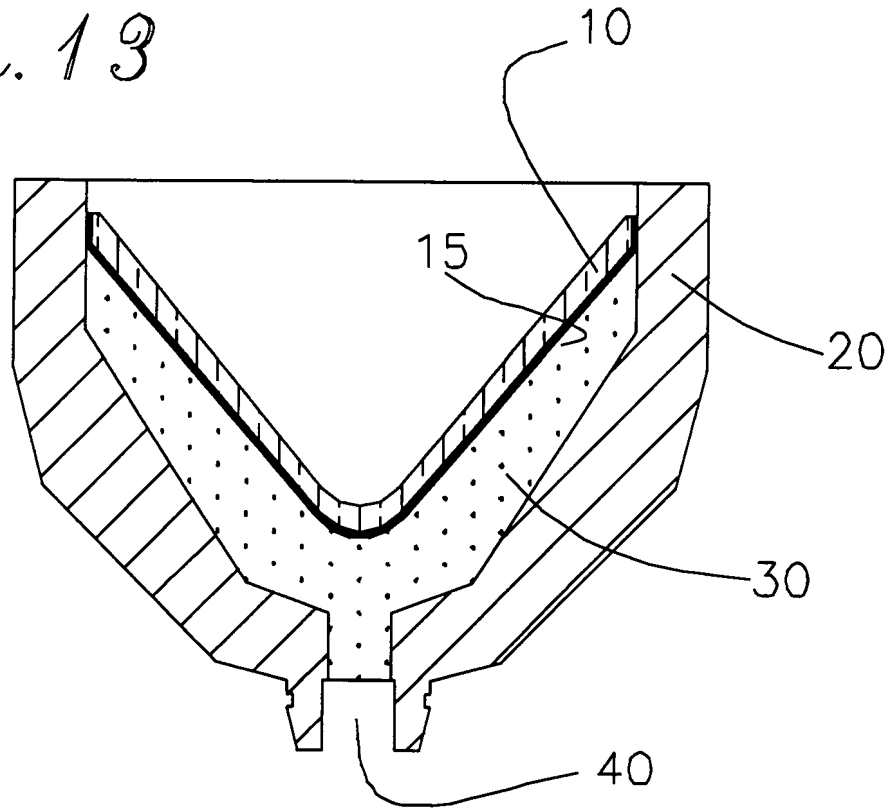
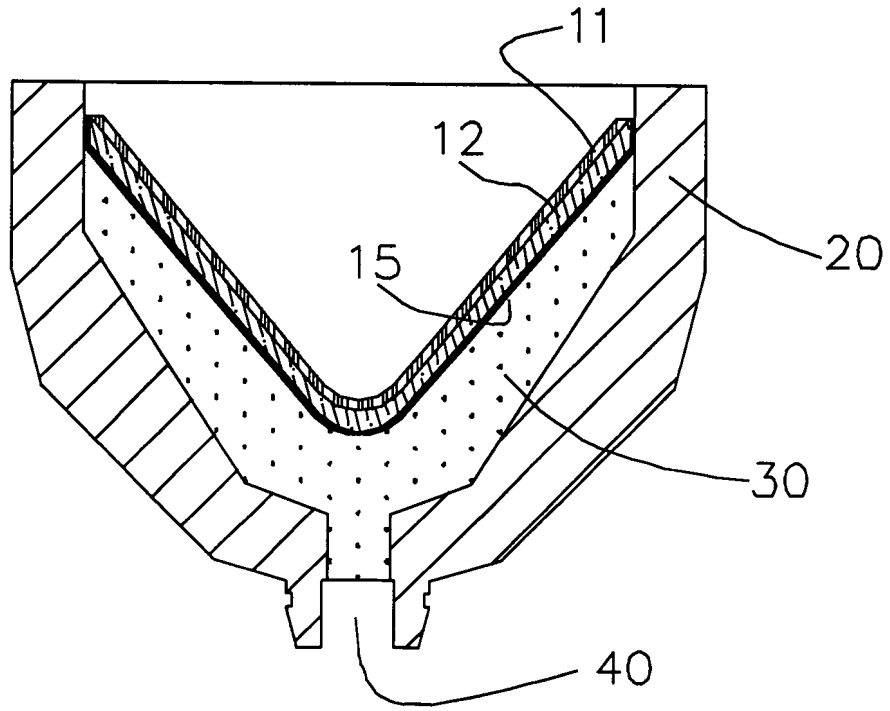


Fig. 14



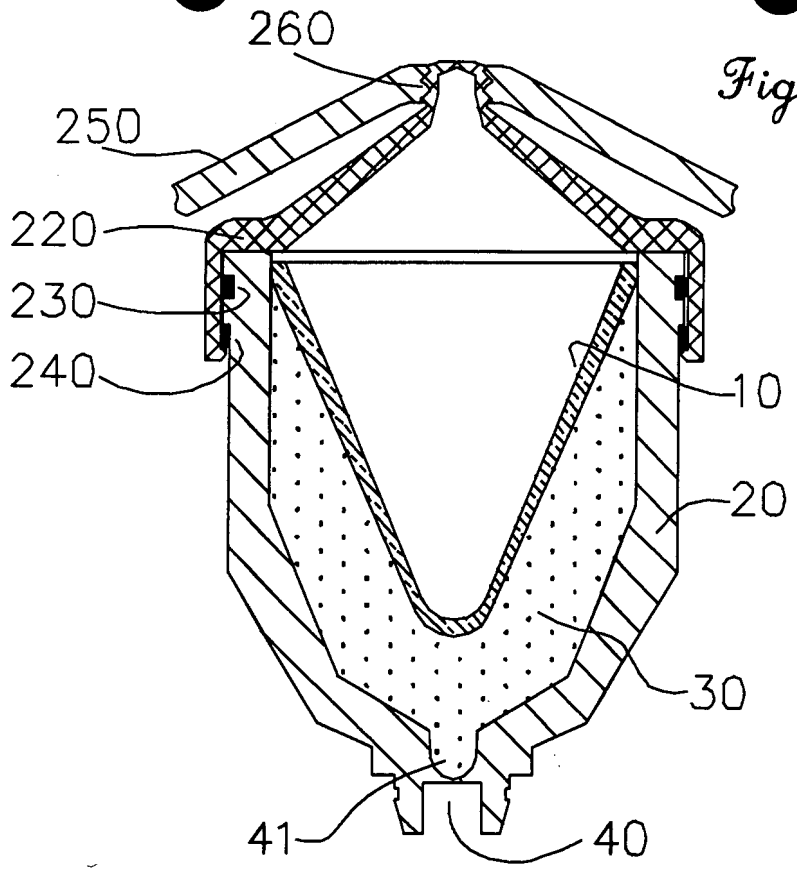

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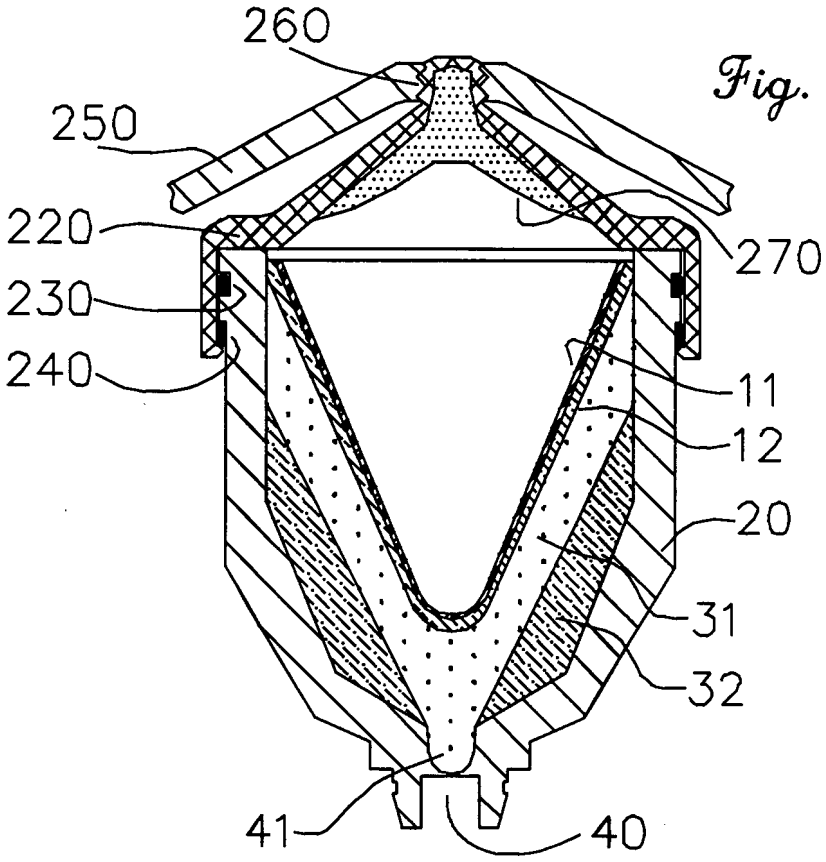
Fig. 15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270
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Fig. 16

Fig. 17

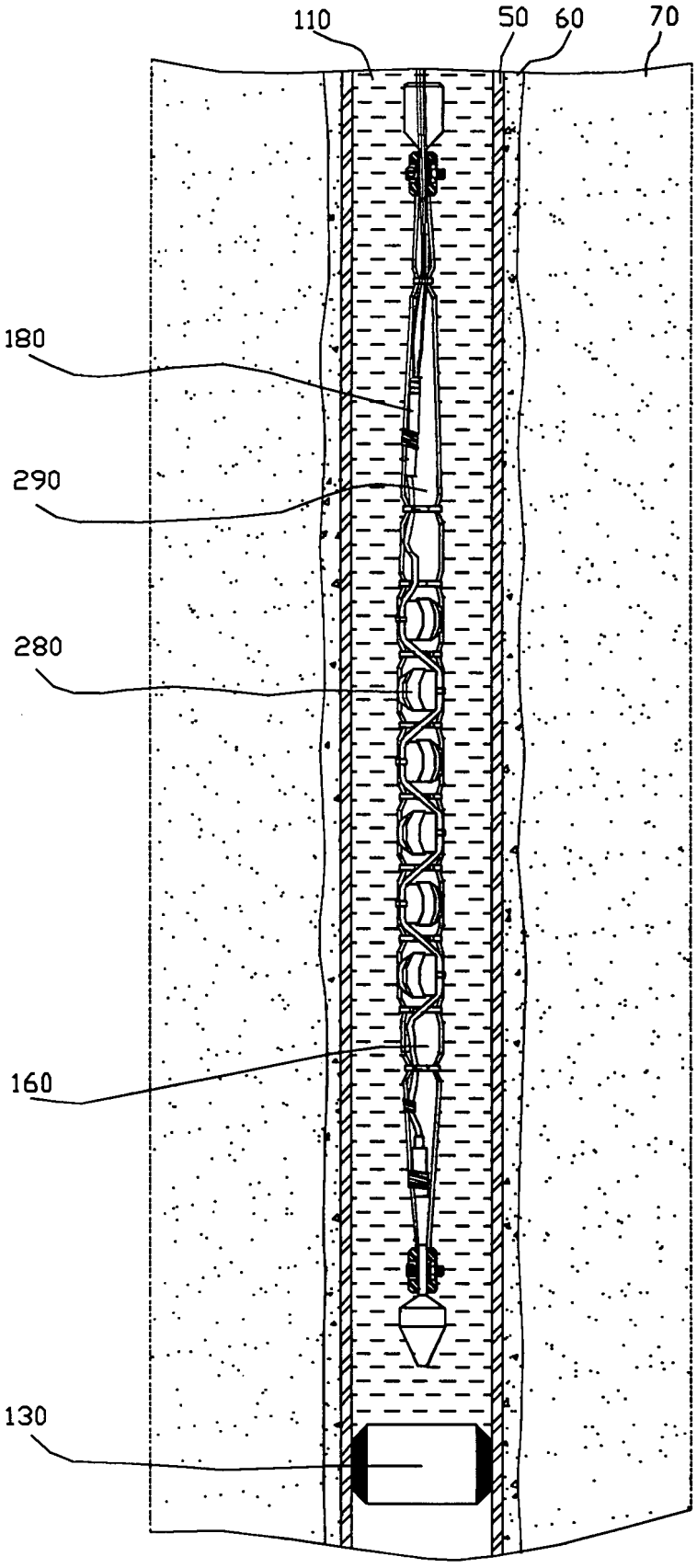


Fig. 18

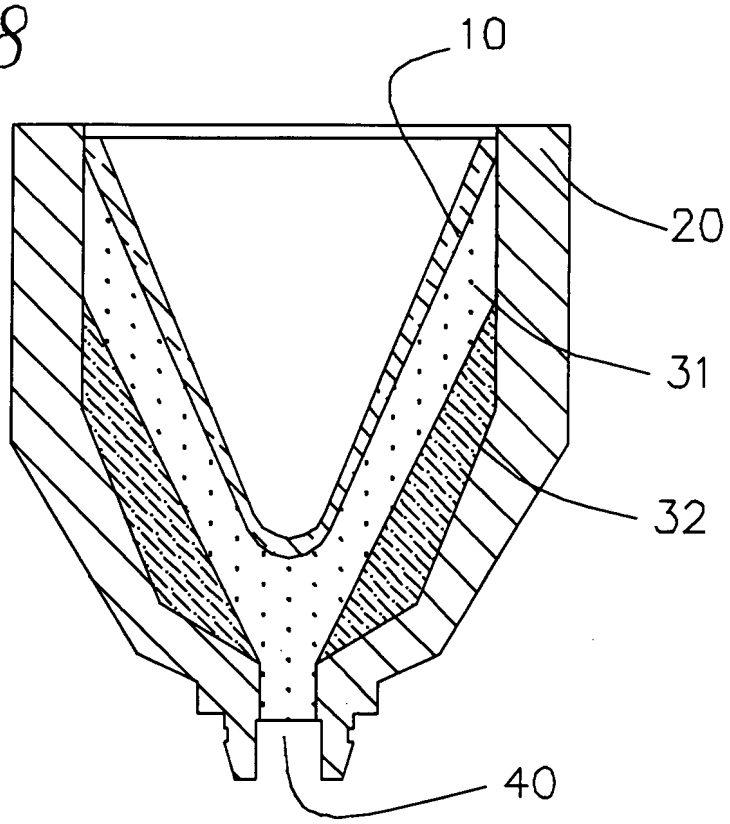


Fig. 19

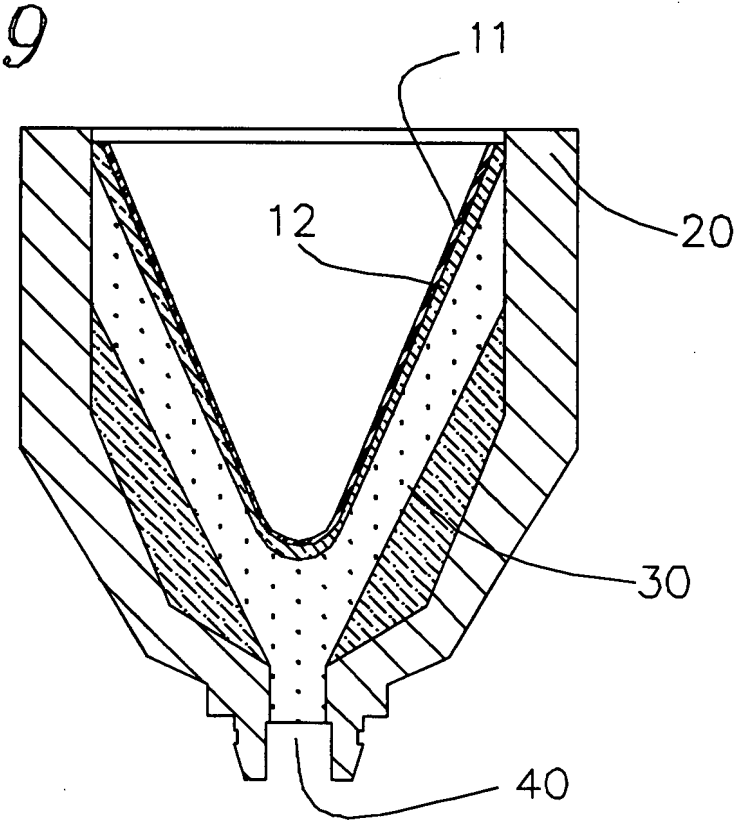
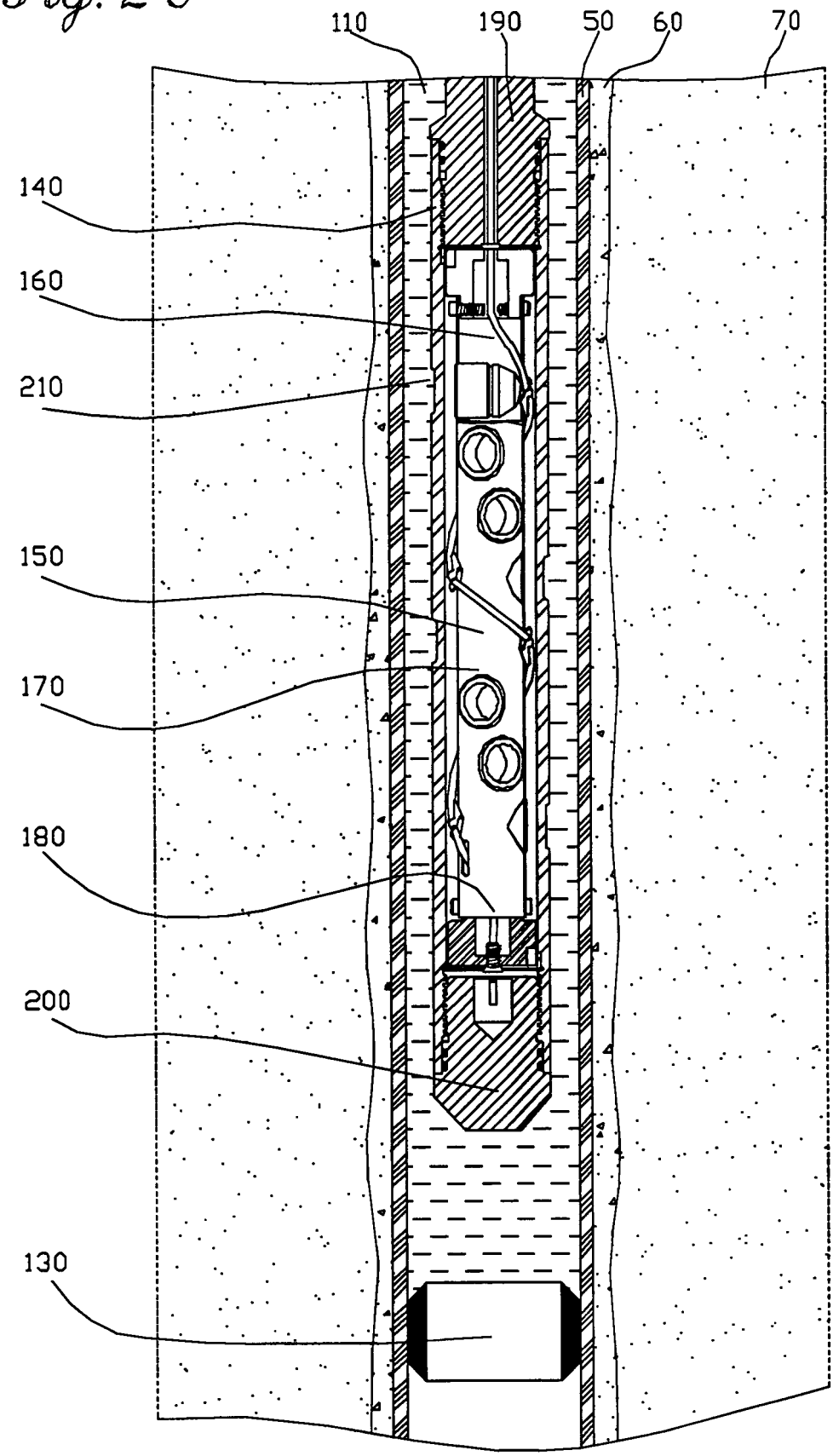


Fig. 20



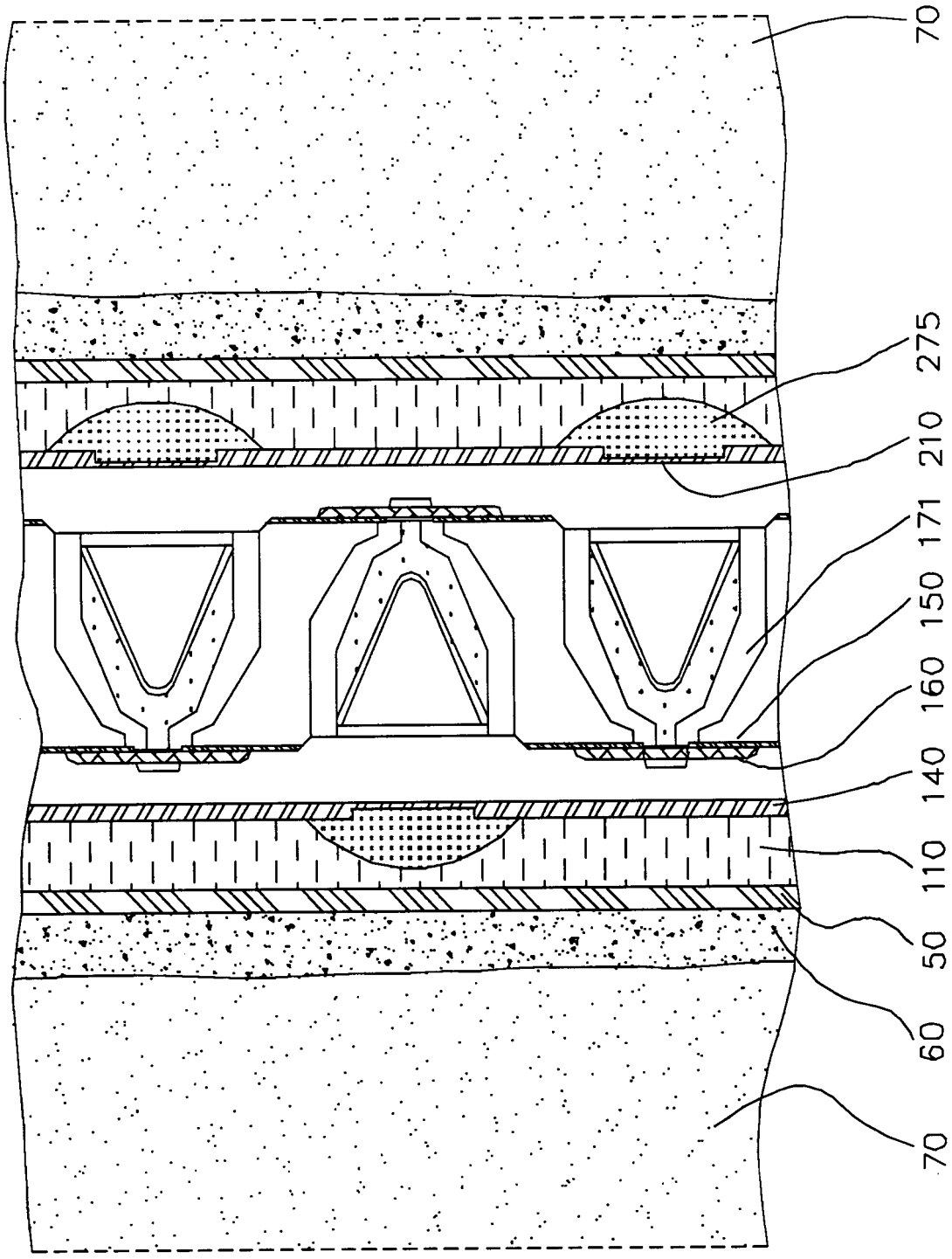


Fig. 21

Fig. 22

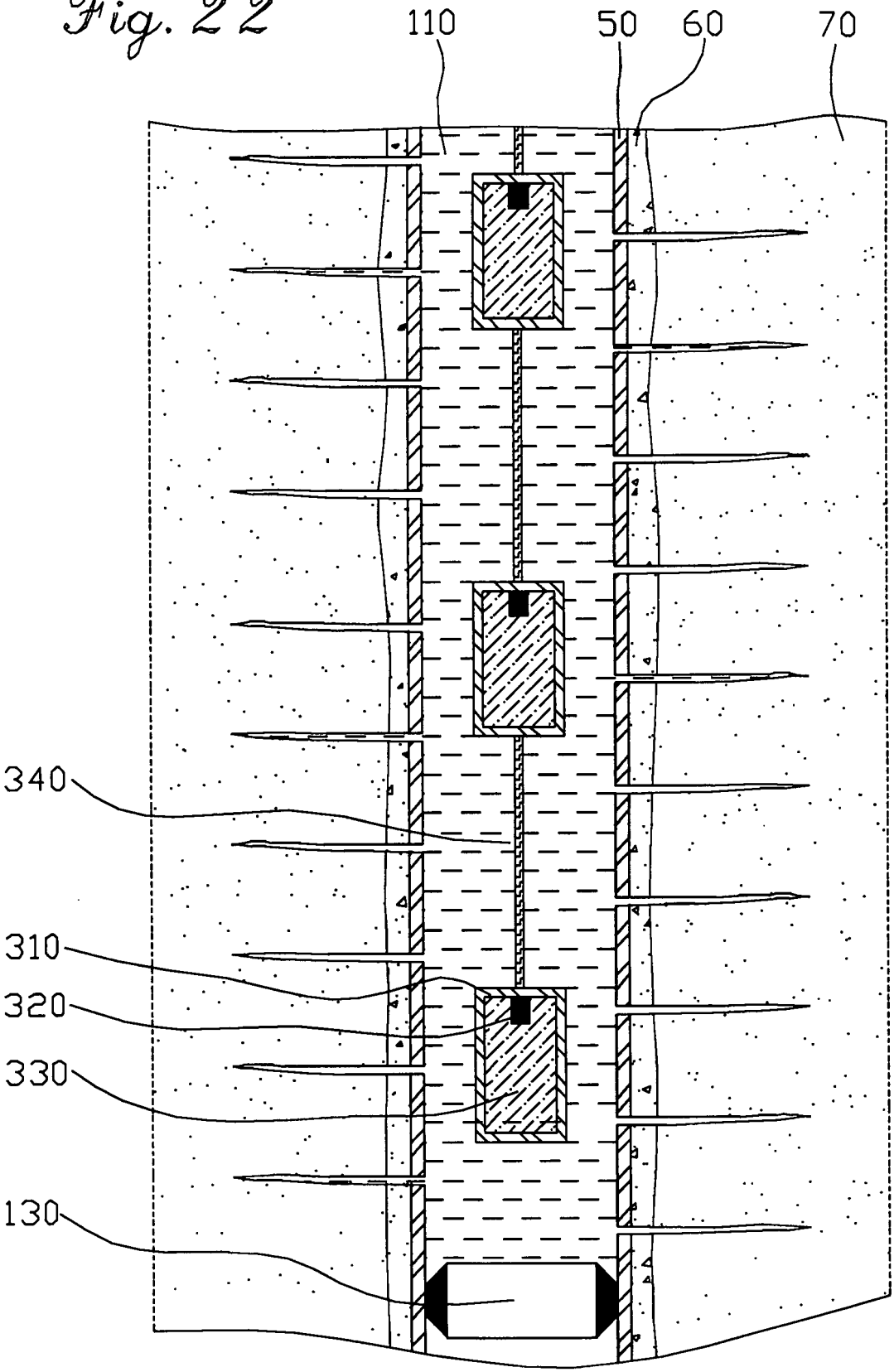
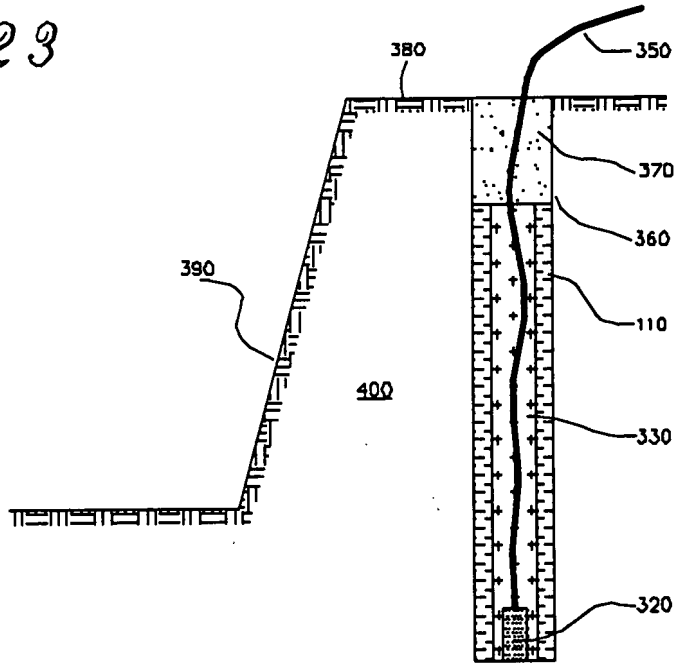


Fig. 23


380
350
370
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110
400
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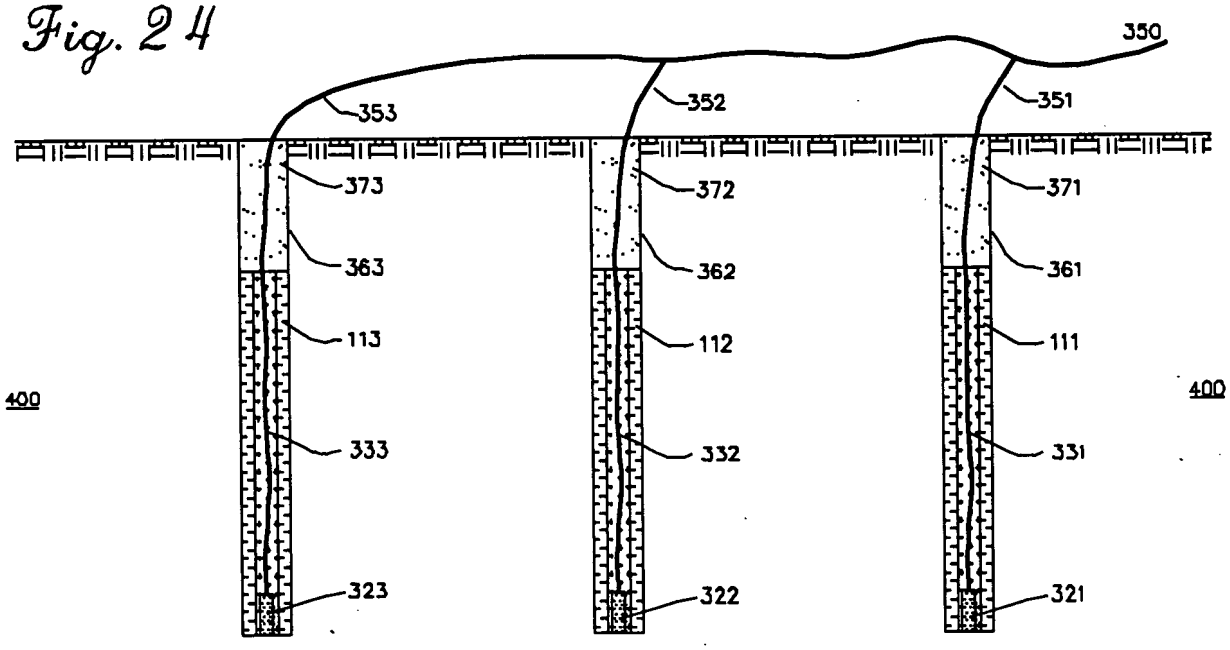
Fig. 24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